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INTERNATIONAL BULLETIN OF BACTERIOLOGICAL NOMENCLATURE AND TAXONOMY

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Official Organ of the Judicial Commission and of the International Committee on Bacteriological Nomenclature of the International Association of Microbiologists

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AND TAXONOMY
R. E. Buchanan, R. S. Breed, S. T. Cowan

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OF
BACTERIOLOGICAL NOMENCLATURE AND TAXONOMY

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VIRUS SUB-COMMITTEE OF THE INTERNATIONAL COMMITTEE ON BACTERIOLOGICAL NOMENCLATURE

THE FOLLOWING is a resumé of the minutes of the meetings of the Virus Sub-committee of the International Committee on Bacteriological Nomenclature held at the Fifth International Congress of Microbiology at Rio de Janeiro, August 1950.

I. Meeting at Petropolis, Brazil, August 19, 1950.

Present:

Dr. C. H. Andrewes (U.K.) Chairman
Dr. G. Bergold (Canada)
Dr. G. Henneberg (Germany)
Dr. P. Lepine (France)
Dr. G. Rake (U.S.A.)

Dr. S. Gard (Sweden) was also present and with the main Committee's consent was later co-opted a member. Dr. R. S. Breed attended during part of the meeting.

The report presented by the Chairman to Section XI (Taxonomy) of the Congress was briefly considered; the draft had previously been circulated. After discussion it was agreed to inform the main nomenclature committee as follows:

1. Of the members of the Virus Nomenclature Sub-Committee who were able to meet at the Rio de Janeiro Congress on August 19th, 1950, all five were animal virologists; they have therefore felt hesitation in making far-reaching recommendations concerning plant viruses without an opportunity for further consultation with plant virologists.

2. The provisional sub-committee declares that the codified systems proposed hitherto for animal viruses as a whole are quite unacceptable. It is not opposed to the eventual application of Linnean binomials to viruses. It would like to encourage the study of virus taxonomy and nomenclature before the 1953 Congress.

First, the principles of classification must be considered, and this must perhaps be done separately for viruses affecting animals, higher plants and bacteria. Next, groups of not more than three specialists should be asked to prepare reports before the next Congress, to be distributed to sub-committee members at least three months before that Congress, these reports should deal with those groups in which there is good basis for classification.

3. The sub-committee asks the Plenary session (or other appropriate body) to declare as follows: A virus sub-committee of the International Nomencla-

ture Committee has been set up and this has taken steps to study before the 1953 Congress the principles of classification of viruses, and their nomenclature. It is urged that, pending the result in 1953 of their deliberations, the use of systems of classifications for and the application of binomials to viruses as a whole are undesirable and should be discouraged.

The sub-committee further noted:

4. The principles upon which the classification of animal viruses should be based are considered to be as follows:
   (1) Morphology and methods of reproduction.
   (2) Chemical composition and physical properties.
   (3) Immunological properties.
   (4) Susceptibility to physical and chemical agents.
   (5) Natural methods of transmission.
   (6) Host, tissue and cell tropisms.
   (7) Pathology, including inclusion-body formation.
   (8) Symptomatology.
   (Symptomatology is purposely placed last, as of minor importance.)
5. The groups of animal viruses upon which a start could be usefully made are thought to be as follows:
   (1) Psittacosis-lymphogranuloma group (*Chlamydozoaceae*).
   (2) Insect-pathogenic viruses.
   (3) Pox group.
   (4) Influenza group (influenza, mumps, fowl-plague).
   (5) Insect-borne encephalitides.

II. Consideration by the Judicial Commission.

The Judicial Commission of the International Nomenclature Committee considered the Virus Sub-committee's statement on August 23rd, 1950, and after discussion, passed the following resolutions:

1. It is recommended to the International Nomenclature Committee and to the Plenary Session that consideration of the starting date for scientific nomenclature of viruses be deferred to the next Congress (passed unanimously).
2. The Judicial Commission expresses an opinion to the Nomenclature Committee and the Plenary Session that until studies on viruses now in progress have advanced further, the use of any comprehensive system of scientific nomenclature for them is unwise. The cooperation of all virologists is requested in assisting the subcommittee now studying the nomenclature and classification of viruses (passed with one dissident vote).

These resolutions were, on August 24th, 1950, unanimously endorsed by the International No-

menclature Committee and the Plenary Session.

It will be noted that despite the hesitancy of the Virus Subcommittee in making recommendations applicable to plant viruses, these resolutions by the full committee refer to all viruses. (It should be explained that the unanimous vote occurred because of the absence of Professor Breed from the room at the time this matter was considered. He had been asked to present the request of the Virus Committee of the American Phytopathological Society that no action on Virus Nomenclature be taken at the Rio de Janeiro Congress. While this matter was discussed in Section XI and by the Judicial Commission it was not considered by the Committee to whom it was addressed).

The Judicial Commission and the Nomenclature Committee, following a resolution forwarded by the Plant Diseases Section of the Congress, asked the virus sub-committee to divide into sections to consider separately the viruses attacking animals, plants and bacteria, these sections to deliberate together at a later date.

The subcommittee, it was felt, would strengthen itself by adding specialists in bacterial viruses. Dr. J. Craigie was therefore added to the subcommittee as Chairman of a phage group and was asked to find two or three others from this field to join the Sub-Committee.

III. Meeting of Virus Subcommittee at Petropolis, August 24th, 1950.

Present:

Dr. C. H. Andrewes (in the Chair)
Dr. G. Bergold (Canada)
Dr. A. Bitancourt (Brazil)
Dr. J. Craigie (U.K.)
Dr. S. Gard (Sweden)
Dr. G. Henneberg (Germany)
Dr. P. Lepine (France)
Dr. G. Rake (U.S.A.)

The sub-committee agreed to divide for the present on the lines suggested by the main Committee. Dr. Craigie was asked to try in the first place to get Drs. Luria and P. Nicolle to join the sub-committee to assist with discussion on bacterial viruses, and failing them, others suitable. Dr. Burnet would probably also help. Dr. Andrewes was asked to invite Dr. Black to act as Chairman of the Plant Virus Section (failing him, Dr. Thung); it was hoped that this Section would try to co-ordinate its activities with corresponding ones of the International Botanical Congress. (Dr. Black later accepted the Chairmanship of the group set up to consider plant viruses).

Plans were discussed for implementing point 5 of the first sub-committee meeting. The fol-

lowing were asked to be conveners of sections to consider classification and nomenclature of certain virus groups:

(1) Dr. G. Rake - psittacosis-lymphogranuloma group *(Chlamydozoaceae)*.
(2) Dr. G. Bergold - insect pathogenic viruses.
(3) Dr. F. M. Burnet - pox group.
(4) Dr. C. H. Andrewes - influenza group (influenza, mumps, fowl-plague).
(5) Dr. P. Lepine - arthropod-borne encephalitides.

These conveners were to have liberty to select the one or two others to join them. These would be asked to accept only if they felt a real interest in virus taxonomy and nomenclature. The following tentative suggestions were made as to suitable workers who might be invited:

(1) Psittacosis group - Dr. Bedson (U.K.), Dr. Gönnert (Germany).
(2) Insect-pathogenic viruses - Dr. Steinhaus (U.S.A.).
(3) Poxes - Dr. Goodpasture (U.S.A.), Dr. Collier (Holland).
(4) Influenza group - Dr. Burnet (Australia), Dr. Francis (U.S.A.).
(5) Arthropod-borne encephalitides - Dr. Hammon (U.S.A.), Dr. Olitsky (U.S.A.).

The sub-committee felt that these study groups should begin work without too much delay and that a good plan would be to prepare a draft scheme which could be circulated for comment to numbers of workers upon the viruses concerned; the small study groups could then consider the question in time to report to the main sub-committee and through it to one of the secretaries of the International Nomenclature Committee at least six months before the next Congress.

Probably some or all of the study groups would decide to put forward provisional binomials for the viruses concerned. If so, they could accept Holmes', or other names, wherever appropriate. The sub-committee felt that while many of Holmes' specific names might be acceptable, his genera were so inadequately described and so heterogeneous that many or most of them would be likely to be rejected. Any new genera or species to be erected could be attributed to the sub-committee as a whole; precedents existed for such action. Wherever possible, descriptions of virus species should select a type strain and name the culture collection holding it. All naming of viruses would be provisional and without prejudice to future decisions as to the starting date for virus nomenclature.

REPORT ON THE SPECIAL COMMITTEE FOR BACTERIA OF THE VII INTERNATIONAL BOTANICAL CONGRESS

Robert S. Breed, Geneva, New York, U.S.A.
and
R. St. John Brooks, Dublin, Ireland.

AS DR. O. N. ALLEN (1) has noted, no formal meetings of the Special Committee for Bacteria were held during the Botanical Congress at Stockholm. This was due, primarily to the fact that those most responsible for the activity of this Committee were involved in the preparation for the Fifth International Congress of Microbiology which was held in Rio de Janeiro one month after the Botanical Congress. While one of us (Brooks) was present at Stockholm, responsibilities in connection with meetings of the International Union of Biological Societies prevented taking an active part in the discussions on nomenclature.

Ever since 1930, the year in which the First International Congress of Microbiology was held in Paris and the Fifth International Botanical Congress was held in Cambridge, England, there has been a willingness on the part of all concerned to turn the chief responsibility for stabilizing bacteriological nomenclature over to microbiologists. In this spirit of cooperation, the International Conference on Botanical Nomenclature that met in Utrecht in June, 1948, appointed the authors of the present report (both of whom were serving at the same time as Permanent Secretaries of the Nomenclature Committee of the International Association of Microbiologists) as Joint Secretaries of this Special Committee for Bacteria of the Botanical Congress. At the same time, the following were appointed members of this Special Committee: W. Beneke (Münster, Germany), J. Ramsbottom (London, England), E. M. Doidge (Pretoria, Union of South Africa, T. Wiken (Zurich, Switzerland).

When notice of our appointment reached the two of us in January of 1949, a preliminary communication was sent to all members of this Special Committee. Only two individuals responded, Dr. Wiken and Prof. Doidge. When this letter finally reached the latter in May of 1949 at P. O. Anesley, Natal, Prof. Doidge replied that having retired to this remote country place he no longer had facilities for work of this kind or

(1). Internat. Bull. Bact. Nomen. and Taxonomy, 1:9. 1951.

for any scientific work. An effort was then made to secure the appointment of more actively interested persons, but Prof. Lanjouw was in Surinam and when he returned, he found the work of preparing for the Botanical Congress so great that nothing further was done. No contact was established with Prof. Beneke or with Dr. Ramsbottom before the Stockholm Congress.

Copies of the Code for Bacteriological Nomenclature that had been adopted by microbiologists at their Fourth International Congress of Microbiology in 1947 were distributed to the Special Committee and some opinion favorable to recommending that the Botanical Congress take formal action recognizing the primary interest of microbiologists in this field was expressed, but could not be formally presented to the Botanical Congress because of the inactivity of the members appointed to the Special Committee for Bacteria of the Botanical Congress. It should be noted that microbiologists, in the Code adopted at Copenhagen, recognize their obligation to work harmoniously both with the botanists and with the zoologists in fields where there are mutual interests.

At Stockholm, Dr. O. N. Allen was appointed as Secretary of a new Special Committee for Bacteria of the Botanical Congress to work with Dr. Ramsbottom in organizing a more active Committee. The interest and competence of Dr. Allen for this work is shown by the excellent report he has presented in this Bulletin of the actions taken by botanists on nomenclature at Stockholm. Dr. Ramsbottom is a member of the International Committee for Bacteriological Nomenclature of the International Association of Microbiologists, and both Dr. Allen and Dr. Wiken were added to this Committee at the Rio de Janeiro Congress of Microbiology. It is hoped that a more active cooperation between botanists and microbiologists can be developed before the next Congresses in these fields are held.

BACTERIOLOGICAL NOMENCLATURE AND TAXONOMY

ALTERNATES FOR MEMBERS OF THE INTERNATIONAL COMMITTEE ON BACTERIOLOGICAL NOMENCLATURE AND FOR MEMBERS OF THE JUDICIAL COMMISSION.

Proposals for Amendment of Provisions 4 and 5 of the International Bacteriological Code of Nomenclature.

THE BOARD of Editors has been requested to prepare a draft copy of an amendment to the International Bacteriological Code of Nomenclature relative to the designation or appointment of alternates for members of the International Committee on Bacteriological Nomenclature and for members of the Judicial Commission when members cannot attend meetings of the Committee or Commission. The following statement has been prepared for consideration by the Judicial Commission.

BOTH THE Judicial Commission and the International Committee on Bacteriological Nomenclature hold regularly scheduled meetings at the time of the triennial International Congresses of the International Association of Microbiologists. It is rarely possible for all members of the Commission or of the Committee to attend. However, it is necessary that decisions be reached at the time of these meetings and without the necessity of recourse to ballots by post. The need for a definite procedure for the designation of alternates authorized to vote in the absence of members has been increasingly apparent at meetings of the Committee and of the Commission.

Several suggestions have been made with reference to appropriate methods of regularizing procedure in the designation or appointment of alternates. It is recognized that the International Committee on Bacteriological Nomenclature is made up primarily of delegates from the various national microbiological societies. Logically these should exercise some authority over the appointment of alternates if they desire. In the absence of nominations from such societies, it is suggested that nominations for alternates might be made by the members who are to be absent, or by the Chairman of the Committee with the Permanent Secretaries.

The Judicial Commission is a creature of the International Committee, and the latter should, if it so desires, elect alternates for absent members. Failure of such designation by the Committee might make appropriate nominations by the absent members or by the Chairman with the Permanent Secretaries.

It is suggested that final approval of nominations of alternates should be the function of the Committee and of the Commission.

Two specific proposals have been formulated for consideration. Proposal No. 1 has to do with appointment of Committee alternates, Proposal No. 2 with appointment of Commission alternates.

Proposal No. 1. Alternates for Members of the International Committee on Bacteriological Nomenclature.

If a member of the International Committee on Bacteriological Nomenclature cannot attend the meetings of the Committee, an alternate having all of the rights of an appointed member will be chosen in accordance with the following provisions:

a. The national microbiological society which the member represents shall have the right to nominate an alternate.

b. If no nomination is made by the national society, the member himself shall have the right to nominate an alternate.

c. If neither national society nor member nominates an alternate, the Chairman of the Committee with the Permanent Secretaries will nominate.

All nominations for alternates by national societies, or by members shall be in writing, and should be in the hands of one of the Permanent Secretaries before the first meeting of the Committee.

All nominations for alternates shall be presented at the first meeting of the Committee, and nominees elected by vote of the Committee will serve as alternates.

Proposal No. 2. Alternates for Members of the Judicial Commission.

If a Commissioner cannot attend the meetings of the Judicial Commission, an alternate having all of the rights of a Commissioner will be chosen in accordance with the following provisions:

a. The Commissioner himself shall have the right to nominate an alternate.

b. If no nomination is made by the Commissioner, the Judicial Commission will elect an alternate from members of the Committee on Bacteriological Nomenclature attending the Congress.

All nominations shall be in writing and in the hands of the Chairman of the Judicial Commission before the first meeting of the Commission. All nominations for alternates

shall be presented at the first meeting of the Commission, and nominees elected by vote of the Commission will serve as alternates.

Procedure

Each member of the Judicial Commission is requested to approve or disapprove the proposed wording of the draft proposals, and to submit such modifications in wording as he may desire. All proposals for revision of wording will be submitted to all members of the Commission for approval or rejection. When the text has been approved by a majority of the members of the Judicial Commission, the proposed amendment will be submitted by the Permanent Secretaries to all members of the International Committee on Bacteriological Nomenclature for consideration and action.

INTERNATIONAL BULLETIN

THE FORMATION OF THE NAMES OF TAXONOMIC GROUPS (TAXA) OF HIGHER RANK THAN GENUS

Proposal for the Emendation of the International Bacteriological Code of Nomenclature

The Board of Editors was directed by the International Committee on Bacteriological Nomenclature at its meeting in Rio de Janeiro in August 1950 to prepare a draft copy of an amendment to the International Code of Bacteriological Nomenclature relative to the formation of the names of taxonomic groups (taxa) of higher rank than genus. The following preliminary statement has been prepared for consideration by the Judicial Commission.

At the time of the adoption of the International Bacteriological Code of Nomenclature at the Copenhagen Microbiological Congress in 1947, final agreement had not been reached as to the rules that should govern the formation of the name of a taxonomic group (taxon) higher than that of a genus. It was therefore agreed that the problem should be considered further by the Judicial Commission and that suitable amendments to the Code of Nomenclature should be formulated for consideration by the International Committee on Bacteriological Nomenclature at the Congress of the International Association of Microbiologists to be held in Rio de Janeiro, Brazil, in 1950.

The Judicial Commission and the International Committee discussed various proposals at the time of the Congress, but were unable in the time available to prepare suitable draft proposals for amendments. However, agreement was reached as to certain general principles and as to procedure. The Board of Editors was directed to prepare such amendments as might be necessary:-

(1). To require that the names of families of bacteria shall be derived from the names of contained genera.
(2). To recommend that the generic name chosen shall be that of the type genus.
(3). To fix definitely the method of formation of the names of other taxonomic groups higher than the genus.

Present Rules in Bacteriology.

The pertinent rules of the International Bacteriological Rules of Nomenclature are as follows:-

Rule 1. Names of divisions, subdivisions, classes, subclasses, orders, suborders, families, subfamilies, tribes and subtribes are taken either from their chief characters or from

a taxonomic unit of the next lower rank.

Rule 2. The names of all ranks higher than the genus are written in the plural number.

Rule 3. The names of divisions subdivisions, classes and subclasses are words of Greek or Latin origin.

Rule 4. Names of orders, suborders, families, subfamilies, tribes and subtribes are also words of Greek or Latin origin or latinized words, each with a suffix to fix its taxonomic rank. The suffix for orders is *-ales*, for suborders *-ineae*, for families *-aceae*, for subfamilies *-oideae*, for tribes *-eae*, and for subtribes *-inae*.

Draft Revision

The Editorial Board has formulated the following proposal for consideration by the members of the Judicial Commission and of the International Committee on Bacteriological Nomenclature. When it is in form acceptable to the Judicial Commission it will be submitted for vote to the members of the International Committee, which was given power to act with respect to this matter by the Fifth International Congress. Comments and criticisms will be welcome; they may be sent to the chairman of the Editorial Board. The draft revision proposed is as follows:-

Rescind Rules 1, 2, 3 and 4 of the Copenhagen Code of 1947 and replace with the following:-

Rule 1. The names of all taxonomic groups (taxa) above the rank of genus are substantives or adjectives used as substantives, of Greek or Latin origin, or latinized words, in the plural number.

Rule 2. Names of all taxonomic groups (taxa) above the rank of family are taken preferably from a combination of characters covering the nature of the groups as closely as possible, or from a single character of outstanding importance. Names of orders and suborders may appropriately be based upon the name of a contained family.

Rule 3. Names of all taxonomic groups (taxa) between suborder and genus are formed by the addition of the appropriate suffix to the stem of the name of a contained genus.

Recommendation 3a. Names of all taxonomic groups between suborder and genus are derived preferably from the name of the type genus.

Note. To avoid disadvantageous changes in certain old or widely used family names which do not conform to Rule 3, exceptions may be made when approved by the International Committee on Bacteriological Nomenclature. The following exceptions

have been approved (1):

Rule 4. Names of taxonomic groups between subclass and genus have suffixes to fix the taxonomic rank. The suffix for orders is *-ales*, for suborders *-ineae*, for families *-aceae*, for subfamilies *-oideae*, for tribes *-eae* and for subtribes *-inae*.

Comparison of Proposed Draft Revision with Botanical and Zoological Rules.

The exact wording of the rules approved at the 1950 Botanical Congress at Stockholm has not as yet been announced. The draft revisions proposed for bacteriology differ somewhat in phraseology but are in substantial conformity with those proposed in botany.

The zoological rules differ from those of bacteriology and of botany in that provision is made for the formation of the names of families and subfamilies and not for the formation of names for other taxa higher than that of genus. The pertinent zoological rules are as follows:-

Art. 4. The name of a family is formed by adding the ending *-idae*, the name of a subfamily by adding *-inae*, to the stem of the name of its type genus.

Art. 5. The name of a family or subfamily is to be changed when the name of its type genus is changed.

It is noteworthy that the zoological rule requires that the name of the family be derived from the name of the type genus. The draft proposal for the bacteriological code recommends but does not require that the names of taxa higher than genus be derived from those of type genera.

Procedure

Under the directives of the Rio de Janeiro Congress the preparation and final approval of the proposed amendment are to be as follows:-

1. The Editorial Board was requested to draft a proposed amendment conforming to the directives of the International Committee. Such draft proposal has been prepared and is submitted herewith for consideration and final formulation by members of the Judicial Commission.

2. Each member of the Judicial Commission will be requested to approve or disapprove by post the proposed wording of the draft proposal. If disapproval is expressed, the member is requested to submit such modifications in wording as he may desire. All such proposals for revision of wording will be submitted by the chairman to

(1). See this Bulletin 1:14. 1951 for proposals.

all members of the Judicial Commission for approval or rejection. When the text has been approved by a majority of the members of the Judicial Commission, the proposed amendment will be sent by the Permanent Secretaries to all members of the International Committee on Bacteriological Nomenclature for a vote.

DERIVATION OF FAMILY NAMES IN BACTERIOLOGY FROM NAMES OF INCLUDED GENERA. REQUEST FOR EXCEPTIONS

A list of seven names of families of bacteria has been submitted to the Judicial Commission and the International Committee on Bacteriological Nomenclature with the request that they be considered for inclusion as a part of the proposal for the emendation of Rule 3 of the International Code of Bacteriological Nomenclature. This emendation would require that all names of families of bacteria be derived from the names of contained genera. Provision is made for the inclusion of exceptions to the rule in the form of a list of names that do not conform to the rule. The following statement gives the background of the request and lists the family names proposed.

The Editorial Board will also publish lists of any additional requests for exceptions made by other individuals. It is anticipated that in all cases proponents of names of families to constitute exceptions will also prepare an objective statement of the pertinent facts and will outline the reasons why the recognition of the exceptions will be desirable. In general it will be the policy of the Editorial Board to publish these statements for the information of the Commission and the Committee. After publication of the statements and after consideration the Judicial Commission will make recommendations to the International Committee.

The proposal (1) for emendation of the rules governing the formation of names of taxonomic groups higher than genus contains a provision to make possible the approval of exceptions of old or widely used family names. The pertinent proposed rule, recommendation, and note read as follows:

Rule 3. Names of all taxonomic groups (taxa) between suborder and genus are formed by the addition of the appropriate suffix to the stem of the name of a contained genus.

Recommendation 3a. Names of all taxonomic groups between suborder and genus are derived preferably from the name of the type genus.

Note: To avoid disadvantageous changes in certain old or widely used families, such names, even though not conforming to Rule 3, may be recognized and accepted as exceptions (2)

(1) This Bulletin 1:7. 1951.
(2) Here will be listed any exceptions approved by the International Committee on Bacteriological Nomenclature.

when approved by the International Committee on Bacteriological Nomenclature. The following exceptions have been approved:-.....

Proposal for Exceptions. It is proposed that the following family names of bacteria be recognized as exceptions to Rule 3 on the basis that they are old names or are widely used.

Coccaceae, *Lactobacteriaceae*, *Enterobacteriaceae*, *Parvobacteriaceae*, *Chlamydobacteriaceae*, *Thiorhodaceae*, and *Athiorhodaceae*.

It is further proposed that a resumé of the origin and status of each of these family names be published in an early issue of the BULLETIN, and that thereafter such names as are approved by the Judicial Commission be referred for final approval or rejection as exceptions to the International Committee on Bacteriological Nomenclature.

INTERNATIONAL BULLETIN

STATUS OF THE GENERIC NAME *BACTERIUM*, THE SPECIFIC NAME *BACTERIUM COLI* AND THE FAMILY NAME *BACTERIACEAE*

Preliminary Statement, File No. 5

The Editorial Board has prepared the following preliminary statement for consideration by the Judicial Commission and for the information of the members of the International Committee on Bacteriological Nomenclature. It is a revision of a statement earlier circulated, and discussed at the meetings of the Commission and of the Committee held at the time of the International Microbiological Congress at Rio de Janeiro (1950). The Judicial Commission, through its Editorial Board, will be pleased to receive comments, criticisms and suggestions from any person interested.

The Judicial Commission has been asked to prepare and issue an opinion fixing the status of the generic name *Bacterium* Ehrenberg, of the specific name *Bacterium coli*, and of the family name *Bacteriaceae*.

PROPOSALS. Two proposals have been received.

1. It is proposed that the generic name *Bacterium* and the family name *Bacteriaceae* be designated as *nomina rejicienda*.

2. It is proposed that the generic name *Bacterium* and the family name *Bacteriaceae* be designated as *nomina conservanda*, that the genus *Bacterium* be designated as the type genus of the family *Bacteriaceae*, that the species *Bacterium coli* be designated as the type of the genus *Bacterium*, and that a type or standard culture be selected for *Bacterium coli*.

The literature of bacteriology reveals much confusion with reference to the use of the generic name *Bacterium* and of the family name *Bacteriaceae*. Proposal No. 1 as submitted to the Commission seeks to eliminate the confusion by the rejection of these names, the second proposal would eliminate the confusion by the careful definition of these names.

The following topics require examination:

A. Rejection or conservation of the generic name *Bacterium* Ehrenberg 1828.

B. Rejection or conservation of the generic name *Bacterium* as proposed or emended by later authors.

C. If *Bacterium* is conserved, designation of its type species.

D. Rejection or conservation of the family name *Bacteriaceae* with the designation of the type genus if the name is conserved.

E. Conservation of the name of

the type species of *Bacterium* if the generic name is conserved.

F. Selection and approval of the type culture for the type species of *Bacterium* if this generic name is conserved.

A. Rejection or conservation of the generic name *Bacterium* Ehrenberg 1828.

The generic name *Bacterium* was first proposed by Ehrenberg (1) in 1828. A single species *Bacterium triloculare* was included in the protozoan family *Vibrioni*. This organism was described as distinctly triocular or triarticulate, subfusiform, hyaline, body terete, 1/300 lines long (approximately 7μ), apparently multiplying by transverse division, and motile. Found in the Oasis of Jupiter Ammon, Siwa. Ehrenberg again described the genus in 1830 (2), then including eleven species, several of them transferred to this genus from various protozoan genera previously described by Mueller. The *Monas termo* of the latter became here *Bacterium termo*. Later Ehrenberg (1832)(3) included two species definitely, and four tentatively. In 1838 he (4) figured *Bacterium triloculare* as a motile rod with one polar flagellum and with the cell divided into two or three compartments. Although included in descriptions by other authors later, there does not seem to have been any subsequent definite identification of *Bacterium triloculare*.

The type species of *Bacterium* Ehrenberg 1828 is *Bacterium triloculare* Ehrenberg 1828 by monotypy. If the genus *Bacterium* Ehrenberg 1828 is placed by international agreement in a list of *nomina generica conservanda* this action would seem to fix the genus and its type species in a non-usable form, since the only species cannot be identified. Further it seems quite improbable that other species placed by later authors in the genus *Bacterium* could be retained in a genus of which *Bacterium triloculare* is the type.

(1). Ehrenberg, C. F. Symbolae Physicae seu Icones et Descriptiones animalium evertebratorum sepositis insectis quae ex itinere per Africam Borealem et Asiam Occidentalem. Berlin. 1928.

(2). Ehrenberg, C. G. Beiträge zur Kenntnis der Organisation der Infusorien und ihrer geographischen Verbreitung. Abhandl.d. Berl.Akad. pp.1-80. 1830.

(3). Ehrenberg, C. G. Die geographische Verbreitung der Infusionsthierchen in Nord Afrika und West Asien, etc. Abhandl.d.k. Akad.d.Wiss.z.Berlin. Physik-Klasse. 1832.

(4). Ehrenberg, C. G. Die Infusionsthierchen als vollkommene Organismen. Leipzig. 1838.

This difficulty of assigning species of bacteria to the genus *Bacterium* as described by Ehrenberg has led to the abandonment of the generic name by many authors. For example, Sternberg (1892) (1) stated "This genus established by Dujardin is now generally abandoned, the species formerly included in it being transferred to the genus *Bacillus*."

Breed, Conn and Baker (1918) (2) likewise suggested that the name be dropped, or at most regarded as a general designation for insufficiently described organisms.

This point of view was later advocated by Breed and Conn (1936) (3) with an important proviso. While recommending that *Bacterium* as a formal generic name be rejected, they believed it advisable to retain it as a tentative but accepted name for those species which previously have been placed in this genus and should remain there until such time as they may be satisfactorily allocated to other genera.

In the sixth edition of Bergey's Manual of Determinative Bacteriology *Bacterium* is defined as follows: "The term *Bacterium* is used to cover species of nonsporeforming rod-shaped bacteria whose position in the system is not definitely established."

Obviously an organism placed in the genus *Bacterium* but so inadequately described as not to be placeable in the appropriate genus must remain as a *species dubia* with its original name retained until proper identification is possible.

B. Rejection or conservation of the generic name *Bacterium* as amended or proposed by later authors.

Bacterium Cohn 1872 (4). Cohn's descriptions were based largely on his concept of *Bacterium termo* as the organism responsible for decay. Transfers of liquid from decaying beans to a medium containing ammonium tartrate yielded a green fluorescence. Later Cohn (1875) (5) included several other species in the genus. Trevisan (1879)

(1). Sternberg, G. M. Manual of Bacteriology. New York. 1892.
(2). Breed, R. S., H. J. Conn and J. C. Baker. Comments on the Evolution and Classification of the Bacteria. Jour. Bact. 3:445-459. 1918.
(3). Breed, R. S. and H. J. Conn. The Status of the Generic Name *Bacterium* Ehrenberg 1828. Jour. Bact. 31:517-518. 1936.
(4). Cohn, Ferdinand. Untersuchungen ueber Bakterien. I. in Cohn's Beitr. z. Biol. d. Pflanzen. 1:127-224. 1872.
(5). Cohn, Ferdinand. Untersuchungen ueber Bakterien. II. in Cohn's Beitr. z. Biol. d. Pflanzen. (Heft 3). 1:141-208. 1875.

(1) used the designation "*Bacterium* Ehrenberg (1830 non 1828) emend. Cohn " and included the species *B. termo*. Apparently Trevisan regarded the first described species *B. triloculare* as non-identifiable, and chose to date the generic name by an Ehrenberg publication containing the description of a species which could be recognized.

Erwin F. Smith (1905) (2) concluded that none of the species placed in the genus before the work of Cohn could be identified. He repeated some of Cohn's experiments and concluded that the *Bacterium termo* of Cohn is a polar flagellate rod capable of producing a fluorescent pigment in a tartrate medium. Smith's characterization of *Bacterium* was rather widely used by those working with bacterial diseases of plants.

Enlows (1920)(3) designated the type species of *Bacterium* (Ehrenberg) emend. Cohn 1872 as *Bacterium termo* (Müller 1773, Ehrenberg 1830, Dujardin 1841, Vignal, Cohn).

Two other workers independently suggested defining the genus *Bacterium* to include the polar flagellate rods. Vuillemin (1913) (4) published a proposal that *Bacterium* be designated as a *nomen genericum conservandum* with *Bacterium termo* Ehrenberg as a prototype and *Bacterium pyocyaneum*, a fluorescent polar flagellate, as the type. Enderlein (5) also defined *Bacterium* to include bacteria with polar flagella, and designated *B. aeruginosum* as the type.

The approval of *Bacterium* Cohn 1872 as a *genus conservandum* with its later designation of type species would make *Pseudomonas* Migula 1894 a later synonym, and would require the use of the name in a way which has not been accepted commonly by bacteriologists. If the proposal (6) to make *Pseudomonas* Migula 1894 a *genus conservandum* is approved, obviously it would need to be conserved against *Bacterium* Cohn 1872.

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(1). Trevisan, V. Primie Linee d'Introduzione allo Studio dei Batterj Italiani. Rend. Real. Inst. Lombardo di Scienze e Lettere IV. Ser II. 12:13-21, 133-151. 1879.

(2). Smith, Erwin F. Bacteria in Relation to Plant Diseases. Carnegie Inst. Washington. 1905.

(3). Enlows, Ella M. A. The Generic Names of Bacteria. Hyg. Lab. Bull. 121, U.S. Public Health Service, Treasury Dept. p. 21. 1920.

(4). Vuillemin, Paul. Genera Schizomycetum. Ann. Mycologie 11:596. 1913.

(5). Enderlein, Bakterien-Cyclogenie. 1925.

(6). (Editorial Board). Status of *Pseudomonas* Migula 1894 as a Generic Name. Intern. Bull. Bact. Nom. and Taxonomy. 1:41. 1951.

The type species of *Bacterium* Cohn 1872 is *Bacterium termo* by monotypy. The species is one which has apparently not been recognized by bacteriologists in recent years. There is some question whether *Bacterium termo* could be identified with sufficient exactness to serve as a type species in practice.

Bacterium Migula 1894. The genus was redefined to include only *nonmotile rod-shaped* organisms either with or without endospores. Migula (1) ascribes the generic name to Cohn. This definition was widely used, particularly in botanical as contrasted with bacteriological circles. The wide acceptance was due in part to the inclusion of Migula's (1895) classification of the *Schizomycetes* in Engler and Prantl's Pflanzenfamilien used so extensively by botanists, to the publication by Migula in 1897 and 1900 of his two-volume System der Bakterien, and to the acceptance of this diagnosis by Chester (1901) in his Manual of Determinative Bacteriology.

In recent years this definition has rarely been accepted by bacteriologists. No designation of a type species of *Bacterium* Migula 1894 has been found in the literature. The author gives *Bacterium anthracis* as an example. If this organism be regarded as the type species either on the basis of the 1914 notation or the definite citation in 1895 (2) the name becomes a later synonym of *Bacillus* Cohn, a generic name conserved by action of the second International Congress of Microbiology in 1936.

Bacterium Lehmann and Neumann 1896. Zopf (1883) (3) modified the definition of *Bacterium* by emphasis upon his concept of pleomorphism. He included in the genus organisms having four growth forms, cocci, short rods, long rods and filaments. Later (1885)(4) he modified his generic diagnosis to include organisms existing as cocci and rods or filaments, with endospore formation *absent* or *unknown*. Apparently this is the first suggestion that absence of spores is of nomenclatural significance. Hueppe (1886)(5) also emphasized absence of endospores as a generic char-

(1). Migula, W. Ueber ein neues System der Bakterien. Arb. Bact. Inst. Karlsruhe 1: 235-238. 1894.
(2). Migula, W. *Schizomycetes*, in Engler and Prantl, Pflanzenfamilien. 1 (1a). 1895.
(3). Zopf, W. Die Spaltpilze. Encyklop. d. Naturwiss. Abt. 1. Lief. 32. 1883.
(4). Zopf, W. Die Spaltpilze. Ed. 3. 1885.
(5). Hueppe, F. Die Formen der Bakterien und ihre Beziehungen zu den Gattungen und Arten. 1886.

acter. However, the more complete characterization of the genus is due to Lehmann and Neumann (1896)(1) who recognized the genus as *Bacterium* Cohn em. Hueppe. Numerous species are described and figured. among these are *Bacterium influenzae* and *Bacterium coli*, Apparently the latter is the first use of the name of the organism named *Bacterium coli commune* by Escherich (2) in its corrected form as a binomial in the genus *Bacterium*. The treatise on systematic bacteriology by these authors went through many editions and resulted in widespread acceptance. No type species was designated.

Orla-Jensen (1909) (3) further proposed to emend the genus to include only the coliform bacteria. He stated "Wir wollen die artenreiche Gattung der Coli-Bakterien einfach *Bacterium* nennen". Winslow *et al* (4) proposed the designation of *Bacterium coli* as the type species. The same recommendation was made by Buchanan (1918)(5).

It would seem that of the proposals for fixing the author of *Bacterium* after Ehrenberg, there are at least three that are worthy of careful scrutiny, namely, the proposal of Cohn that the genus *Bacterium* and its species *Bacterium termo* be defined to include the typical decay-inducing organisms producing a greenish fluorescent pigment; the proposal of Migula that the name be used to include the non-motile rod-shaped bacteria; and the proposal or emendation developed by Lehmann and Neumann in which there is emphasis upon differentiation of *Bacterium* from *Bacillus* on the basis of lack of endospore formation in the former.

One of these proposals may be accepted by international agreement as the legitimate publication of *Bacterium* as a generic name and the genus placed in the list of *genera conservanda*. The names as proposed by other authors would be placed in the list of *genera rejicienda*.

(1). Lehmann, K.B. and R. Neumann. Atlas und Grundriss der Bakteriologie. Teil II. Text. p. 224. 1896.

(2). Escherich, Th. Die Darmbacterien des Neugeborenen und Saeugling. Fortschr.d.Med. 3:520. 1885.

(3). Orla-Jensen, S. Die Hauptlinien des natuerlichen Bakteriensystems. Zentr.f.Bakt. Abt.2. 22:305-346. 1909.

(4). Winslow, C-E.A., Jean Broadhurst, Chas. Krumwiede, L.A.Rogers, and G. H. Smith. (Committee of the Society of American Bacteriologists on Characterization and Classification of Bacterial Types). Preliminary Report. The Families and Genera of Bacteria. Jour. Bact. 2:552. 1917.

(5). Buchanan, R.E. Studies in the Nomenclature and Classification of the *Bacteriaceae*. Jour. Bact. 3: 27-61. 1918.

C. Designation of the type species of the genus Bacterium

1. *Bacterium* Ehrenberg 1828. The type species by monotypy is *Bacterium triloculare* Ehrenberg 1828. Conservation of the generic name *Bacterium* Ehrenberg 1828 would probably make the name useless from the standpoint of assignment to it of other species of bacteria placed in the genus *Bacterium* as recognized by later authors. To fix upon *Bacterium triloculare* as the type would be the equivalent of rejecting the generic name, at least of placing it in a list of *nomina dubia* or *nomina inquirenda*. Rule 24 (6 and 7) of the International Bacteriological Code reads:

"A name of a taxonomic group is illegitimate in the following cases:-

(6). If its application is uncertain (*nomen dubium*), a list of names to be abandoned for this reason will be included under *nomina rejicienda*.

(7). If the characterization of the group was based upon an impure or mixed culture. A list of names to be abandoned for this reason (*nomina confusa*) will be included under *nomina rejicienda*."

Rejection of the generic name *Bacterium* Ehrenberg 1828 would make possible the recognition of the generic name *Bacterium* as proposed by some later author, if such action should be approved by international agreement.

2. *Bacterium* Cohn 1872. The type species by monotypy is *Bacterium termo*. Interpretations and emendations by later authors would include in the genus polar flagellate rods that produce fluorescent pigment when grown in Cohn's nutrient solution. The species *Bacterium termo* is not recognized by most bacteriologists at the present time because it probably was not based upon a pure culture and is at present unidentifiable. Designation of a type species as recommended by several later writers would require international approval. The acceptance of *Bacterium* Cohn 1872 would probably make *Pseudomonas* Migula 1894 a later synonym.

3. *Bacterium* Migula 1894. No record of the definite designation of a type species has been found. If the type were fixed upon as *Bacillus anthracis* the generic name would be a later synonym of *Bacillus* Cohn.

4. *Bacterium* Lehmann and Neumann 1896. These authors did not designate a type species. *Bacterium influenzae* was the first

species described. Escherich (1885 l.c.) gave the name *Bacterium coli commune* to one of the first organisms to be placed in this genus, adequately characterized and still recognized. Unfortunately he used a trinomial to designate the organism, technically rendering the name illegitimate. Apparently the first binomial designation of the organism was *Bacterium escherichii* Trevisan 1889 (1). This name has never come into use. The organism was named *Bacillus coli* by Migula (1895) and *Bacterium coli* by Lehmann and Neumann (1896). The correct designation would seem to be *Bacterium coli* (Migula) Lehmann and Neumann. *Bacterium coli* was designated as the type species of *Bacterium* by Winslow *et al* (1917 l.c.) and by Buchanan (1918 l.c.). The description and figures given by Lehmann and Neumann are adequate for the identification of the species. This designation of the type has been recognized and approved by many workers. It would seem that *Bacterium coli* (Migula) Lehmann and Neumann is the type species of *Bacterium* Lehmann and Neumann 1896 by subsequent designation from included species.

If *Bacterium* Lehmann and Neumann 1896 is conserved, it is advisable to note other generic names against which it should be conserved. These would include all names of genera and subgenera that are based on the same type species. Among these are the following: *Escherichia* Castellani and Chalmers 1918, *Colibacterium* Orla-Jensen 1921, *Enterobacter* Rahn 1937 and *Enterobacterium* Gieszczykiewicz 1939. If *Bacterium* Lehmann and Neumann is made a *genus conservandum*, these four generic names become later synonyms. If *Bacterium* is not conserved, these names should be examined as to their legitimacy and availability.

4a. *Escherichia* Castellani and Chalmers 1918. The type species was definitely designated by the authors as *Escherichia coli* (Escherich) Castellani and Chalmers 1919. If *Bacterium* is conserved with *Bacterium coli* as the type species, *Escherichia* becomes a later synonym.

4b. *Colibacterium* Orla-Jensen 1921. The author states: "The genus *Bacterium* will undoubtedly dissolve into several genera of which I may especially mention the *Colibacterium* and *Aerogenesbacterium*." The legitimacy of *Colibacterium* requires study. Orla-Jensen suggested dividing the genus *Bacterium* into two genera. Rule 17 of the International Bacteriological Code of Nomenclature reads:-

(1). Trevisan, V. I Genera e le Specie delle *Bacteriaceae*. Milan. 1889.

"When a genus is divided into two or more genera the generic name must be retained for one of them, or (if it has not been retained) must be reestablished. When a particular species was originally designated as the type the generic name must be retained for the genus including that species."

It would seem that *Colibacterium* is illegitimate on the basis that it has the same type species as *Bacterium* as recognized by Orla-Jensen. Further, the name *Colibacterium* seems to have been proposed quite provisionally and not definitely. Rule 12 of the code states in part:-

"A name of a taxonomic group is validly published only if it has been definitely accepted by the author who published it. A name proposed provisionally (*nomen provisorium*) in anticipation of the eventual acceptation of the group, or of the circumscription, position or rank given to a group, or mentioned only incidentally is not validly published."

Further, Rule 13 states:-

"A name of a genus is not validly published unless it is accompanied (1) by a description of the genus; or (2) by the citation of a previously and effectively published description of the genus under another name; or (3) by a reference to a previously and effectively published description of the genus as a subgenus, or other subdivision of a genus."

Colibacterium should probably be excluded from consideration as a generic name inasmuch as it has not been validly published.

4c. *Enterobacter* Rahn 1937 (1). Rahn's characterization of the genus is included in the following statements:-

"The need for a name for the entire colon-typhoid group has been felt by those bacteriologists who do not agree with Castellani and Chalmers' many genera (except as trivial names). The name *Enterobacteriaceae* as a family name with the single genus *Enterobacter* is here proposed. The term is not entirely inclusive since such species (sic) as *Serratia*, *Aerobacter* and *Erwinia* are in this group which are not intestinal. However, it is not necessary that a family or genus name describe all species."

(1). Rahn, Otto. New Principle for the Classification of Bacteria. Zent. f. Bakt. Abt. II. 96: 273-286. 1937.

An interesting footnote is appended. "Two other names have been proposed. One is the neutral expression *Virgula*, the Latin name for the Greek *Bacterium*...."

In a tabular outline of the *Eubacteriales* the author gives a description of a new family *Enterobacteriaceae* and follows with the statement:-

> "*Enterobacter* (including *Escherichia, Salmonella, Aerobacter, Klebsiella, Proteus, Erwinia, Shigella,* and the gas-formers of *Serratia, Pseudomonas, Flavobacterium* and *Achromobacter*."

The legitimacy of the name *Enterobacter* must be scrutinized. Rule 19 of the Bacteriological Code states:-

> "When two or more groups of the same rank are united, the oldest legitimate name or (in species and their subdivisions) the oldest legitimate epithet is retained. If the names or epithets are of the same date, the author who unites the group has the right of choosing one of them."

It would seem that Rahn disregarded this rule, common in essence to botany, bacteriology and zoology. No type species is designated. The validity of publication may also be questioned under Rule 13 above cited. *Enterobacter* is probably to be regarded as not validly published, perhaps it may be regarded as a *nomen nudum*.

4d. *Enterobacterium* Gieszczykiewicz 1939.(1).This author accepts the generic name *Bacterium* which he subdivides into 12 subgenera, of which the first is *Enterobacterium.* The subgenus is described and the statement made: "Typus: *Bacterium (Enterobacterium) coli* Escherich."

The subgeneric name apparently was validly published. Its standing should be examined under Rule 5, last sentence of paragraph 1:

> "Generic names and subgeneric names are subject to the same rules and recommendations and, from a nomenclatural standpoint, they are coordinate."

However, There is a question as to conformity with the next sentence of Rule 5:

> "If a genus is divided into subgenera, one of the subgenera (that which includes the type of the genus) should

(1). Gieszczykiewicz, M. Zur Frage der Bakterien-Systematik. Bull. d.l'Acad. Polonaise. Sc.Lettres. Classe Sc.Math.et Nat. Ser. Sc. Nat. (1) 9-27. 1939.

bear the same name as the genus."

This would seem to indicate that the name *Bacterium* rather than *Enterobacterium* should have been chosen as the name of the subgenus. The author definitely includes in his subgenus *Enterobacterium* the genera *Escherichia, Aerobacter, Eberthella, Salmonella, Shigella, Klebsiella.*

The point may be made that this author definitely recommended the use of the generic name *Bacterium*, and would seem by inference to have fixed upon *Bacterium coli* as the type species. *Enterobacterium* is a later synonym of *Escherichia* because it is based on the same type species.

Every effort in the preceding statement has been made to confine the discussion to problems of nomenclature. All that is here involved is the fixing of the type species for *Bacterium* if the name is conserved, or the rejection of the generic name completely if it is not conserved. The number of species that should be included in a conserved genus *Bacterium* or the number of other genera to be included in the family to which it is assigned are important, but are not primarily problems of nomenclature.

If *Bacterium* Lehmann and Neumann is conserved with the type species *Bacterium coli* (Migula) Lehmann and Neumann, then all genera having the same type species are synonyms and can not be used legitimately as generic names. For example, *Escherichia* would become a synonym, but *Aerobacter, Salmonella, Shigella*, etc. could be used as at present to designate different genera or they could be merged in the genus *Bacterium* to any degree desired. There might well be some nomenclatural problems involved. For example, the oldest generic name of a genus that probably would be included in the family to which *Bacterium* is assigned is *Serratia*. If *Bacterium* and *Serratia* were united, under the rules the older name would be applied to the genus. Effective conservation of the generic name *Bacterium* would require that it be conserved against all older genera having different type species as well as those having the same.

D. Rejection or conservation of the family name *Bacteriaceae* and designation of the type genus.

The family designation *Bacteriaceae* was apparently first used by Cohn (1872 1c.) In his description of *Microsphaera* he employed the expression "Gruppe der *Bacteriaceae*." Apparently the name was used to include all *Schizomycetes* in this family

was described in some detail by Trevisan (1879) and has been used by many other authors since. Some of the earlier students employed the family name as all-inclusive, but in recent years it has in general been more restricted in its application.

One proposal before the Commission is that the family name *Bacteriaceae* be rejected, the other that it be made a *nomen familiae conservandum*. The name is derived from the name of one of the contained genera, *Bacterium*.

Obviously conservation of the family name *Bacteriaceae* may be dependent upon the conservation of a generic name *Bacterium* from which the name could be derived. The family *Bacteriaceae* would include such genera as are regarded as sufficiently closely related to *Bacterium*. What names should be given to those genera would be determined by whether *Bacterium* Ehrenberg 1828, with its type species *Bacterium triloculare*, or *Bacterium* Cohn 1872 with its type species *Bacterium termo*, or *Bacterium Migula* with some type species to be selected, or *Bacterium* Lehmann and Neumann with its type species *Bacterium coli* is chosen as the generic name to be conserved.

Inasmuch as one proposal is that *Bacterium* be so fixed that *Bacterium coli* is its type, it is well to examine whether there are other family names that might have priority, and against which it would be necessary to conserve the family name *Bacteriaceae*. One family name that has come into some use requires further consideration, *Enterobacteriaceae* Rahn 1937.

Enterobacteriaceae Rahn 1937. This author characterized the family and assigned to it a single genus, *Enterobacter*, which in turn was defined to include the older genera *Escherichia, Salmonella, Aerobacter, Klebsiella, Proteus, Erwinia, Eberthella, Shigella,* and the gas-formers of *Serratia, Pseudomonas, Flavobacterium* and *Achromobacter*. The name *Enterobacteriaceae* presumably is derived from *Enterobacter*. The validity of the name *Enterobacteriaceae* may be tested through application of the Rules and Principles of the International Bacteriological Code of Nomenclature. Among these are the following:

Rule 24. A name of a taxonomic group is illegitimate in the following cases: (1) If it was nomenclaturally superfluous when published, i.e., if the group to which it was applied, as circumscribed by its author, included the type of a name which the author ought to have adopted under one or more of the rules.

Principle 9. Each group with a given circumscription, posi-

tion and rank can bear only one valid name, the earliest that is in accordance with the Rules of Nomenclature. Provisions may be made for certain exceptions. Note: In subgenera, genera, and groups of higher rank, the valid name is the earliest name published, provided that this is in conformity with the Rules of Nomenclature.

Principle 11. The application of names of taxonomic groups is determined by means of nomenclatural types. A nomenclatural type is that constituent element of a group to which the name of the group is permanently attached, whether as an accepted name or as a synonym. The name of a group must be changed if the type bearing that name is excluded.

Rule 9. For each valid name of each taxonomic group there should be designated a type; that is for each species or subspecies a type culture, specimen, or description, for each genus a type species (genotype).

Rule 12. (in part). A group is not characterized and the publication of its name is not validated merely by mention of the subordinate groups included in it; thus, the publication of the name of an order is not validated by mention of the included families; that of a family is not validated by mention of the included genera; that of a genus is not validated by mention of the included species.

It would seem that Rahn characterized the family name *Enterobacteriaceae* both by giving a description and giving the name of the single included genus, *Enterobacter*. However, the genus *Enterobacter* was not characterized and no species was named. Under Rule 12 *Enterobacter* was not validly published and is a *nomen nudum*. Even if validly published, it would be a later synonym of one of the genera included within it.

The family name *Enterobacteriaceae* Rahn was accepted, adequately characterized and used by Bergey, Breed, Murray and Hitchens (1939)(1) in the fifth edition of Bergey's Manual and also by Breed, Murray and Hitchens in the sixth edition (1948). However, the generic name *Enterobacter* was not accepted, nor was it listed as a synonym of any of the several contained genera.

Family names should be derived from names of contained genera.

(1). Bergey, David H., Robert E, Breed, E.G.D.Murray and A. Parker Hitchens. *Enterobacteriaceae*, in Bergey Manual of Determinative Bacteriology, Ed.5. p. 388. 1939.

However, approval was given at the fifth Congress of Microbiology at Rio de Janeiro to the validation of family names not so derived, providing that there is international agreement. There has been no proposal submitted to the Judicial Commission that *Enterobacteriaceae* Rahn be designated as a *familia conservanda*. If *Bacteriaceae* is designated as a conserved family name based upon the genus *Bacterium* with *Bacterium coli* as a type species, the family name *Enterobacteriaceae* becomes a synonym. The use of the family name *Enterobacteriaceae* has become rather common among those who base their bacterial nomenclature upon Bergey's Manual. For example, questions of nomenclature which arise in the indexing and abstracting in Biological Abstracts are generally settled by reference to this Manual. The name has been frequently used in texts and in scientific articles.

On the other hand, it should be recognized that many bacteriologists, as evidenced by the request of the British Committee for conservation of *Bacteriaceae*, have vigorously opposed the introduction and advocacy of the family name *Enterobacteriaceae*. The name has been regarded as a wholly unjustified replacement of an old, valid and widely accepted name by one not formed in conformity with the rules of nomenclature. Many bacteriologists have refused to accept the new name in their scientific writings and in their texts.

Some international agreement which would do away with widespread confusion and misunderstanding is desirable.

Further examination of the origin and status of the name *Enterobacteriaceae* may be useful.

Rahn's concept of a good family name is that of one which is descriptive of all the organisms contained within it and one that includes a clear indication of some characteristic common to all. He is somewhat apologetic for the family name *Enterobacteriaceae* as not fully meeting this requirement. He apparently regards *Enterobacteriaceae* as the equivalent of enterobacteria, that is, the intestinal bacteria. He notes that the name does not properly characterize all the organisms contained. He says (p. 381); "The term is not entirely inclusive since such species (*sic*) as *Serratia*, *Aerobacter* and *Erwinia* are in this group which are not intestinal. However, it is not necessary that a family or genus name describes all species." It may be noted that Rahn also included in his family the gas-formers "of *Pseudomonas*, *Flavobacterium* and *Achromobacter*." In other words, of the twelve genera brought together six did not fall logically into the group of the enterobacteria

of intestinal bacteria on the basis of habitat.

Although there is no warrant in any of the three biological codes of nomenclature for the point of view that the name of a genus or of a family should in its etymological makeup indicate a characteristic common to all the contained organisms, nevertheless this point of view has not infrequently been held by bacteriologists.

The ending *-aceae* as used as a suffix in the formation of family names, originally a plural adjective suffix, has become in practice a plural noun ending meaning "Those organisms which resemble...". If the suffix is added, as is customary, to the stem of the name of a contained genus, the family name becomes highly descriptive. It is obvious that the several genera are grouped together in a family because they resemble the genus whose name has been modified to become the family name.

If the family name *Bacteriaceae* is rejected, it would seem desirable that the status of the family name *Enterobacteriaceae* be fixed by international agreement, and the type genus definitely designated.

The Editorial Board, after a survey of the facts presented above, has developed the following statement as logically representing the various alternatives to be considered by the Judicial Commission in its formulation of an official opinion as to the conservation or rejection of the generis name *Bacterium* and the family name *Bacteriaceae*.

Alternatives suggested for consideration by the Judicial Commission.

The Judicial Commission should determine whether stability and uniformity in bacteriological nomenclature would be advanced by an OPINION embodying one or more of the following alternatives.

a. Rejection or conservation of the generic name *Bacterium*.

b. The generic name *Bacterium* Ehrenberg 1828 should be conserved (The type species would be *Bacterium triloculare* Ehrenberg 1828.)

2b. The generic name *Bacterium* Ehrenberg 1828 should be rejected.

c. Rejection of *Bacterium* Ehrenberg should make the name *Bacterium* permanently unavailable for the name of a bacterial genus.

2c. Rejection of the generic name *Bacterium* Ehrenberg 1828 should not prevent the use of *Bacterium* as the name of a genus based upon a diagnosis and proposal of some later author and conserved in such use by international agree-

ment.

d. *Bacterium* Cohn 1872 (with type species *Bacterium termo* Cohn) should be
e. Conserved
2e. Rejected

2d. *Bacterium* Migula 1894 (with type species to be designated) should be
e. Conserved
2e. Rejected

3d. *Bacterium* Lehmann and Neumann 1896 (with the type species *Bacterium coli* (Migula) Lehmann and Neumann) should be
e. Conserved
2e. Rejected

4d. *Bacterium* _____ _____ shall be ascribed to _____ (authority) with _____ _____ as the type species and should be conserved.

2a. Rejection or conservation of the family name *Bacteriaceae*.
b. The family name *Bacteriaceae* should be rejected and made unavailable for future use as a family name. (The Judicial Commission may be requested to prepare an Opinion relative to the desirability of conservation of the family name *Enterobacteriaceae*).

2b. The family name should be conserved with the type species
c. *Bacterium triloculare* Ehrenberg 1828.
2c. *Bacterium termo* Cohn 1872.
3c. *Bacterium* _____ Migula 1894.
4c. *Bacterium coli* (Migula) Lehmann and Neumann 1896.
5c. *Bacterium* _____ _____ _____

3a. Should a decision be reached to conserve the generic name *Bacterium*, the Judicial Commission should develop a method to fix the type culture of the type species.

THE GENDER TO BE ASSIGNED TO NAMES OF BACTERIAL GENERA WHICH END IN *-BACTER*.

Preliminary Statement. File No. 3

The Judicial Commission was asked to prepare an opinion relative to the gender of the names of bacterial genera having *-bacter* as the last component. The two Permanent Secretaries of the International Committee on Bacteriological Nomenclature, Dr. R. St. John-Brooks and Dr. Robert S. Breed, and the Chairman of the Judicial Commission prepared a preliminary statement which was sent to all members of the Judicial Commission to secure their decisions as to the essentials to be included in the Opinion to be formulated. Upon receipt of the ballots, an Opinion (see page 36 this BULLETIN) was prepared and submitted to the Judicial Commission at the meeting held in August, 1950, at Rio de Janeiro. That there may be an understanding of the facts on which the Opinion was based, a slightly revised copy of the preliminary statement submitted for consideration by the members of the Judicial Commission is presented herewith.

Many names of genera, subgenera and "physiological genera" with the last component *-bacter* have been proposed in bacteriology. An incomplete survey of the literature shows at least 42, namely: *Acetobacter, Acetogluconobacter, Achromobacter, Actinobacter, Aerobacter, Amoebobacter, Amylobacter, Aplanobacter, Arthrobacter, Astrobacter, Azotobacter, Butylobacter, Caulobacter, Citrobacter, Colibacter, Cystobacter, Cytobacter, Enterobacter, Euacetobacter, Eugluconobacter, Fenobacter, Flexibacter, Flavobacter, Gleobacter, Gluconoacetobacter, Glucobacter, Gluconobacter, Glycobacter, Granulobacter, Lactobacter, Lipobacter, Myxobacter, Nitrobacter, Pectinobacter, Photobacter, Phytobacter, Protaminobacter, Proteobacter, Radiobacter, Saccharobacter, Siderobacter, Streptobacter, Urobacter.*

Authors of these names are not in agreement as to their gender; some have regarded the names proposed as masculine, others as neuter; in some cases both masculine and neuter; in other cases the specific epithets used do not indicate gender; in still others, the names introduced are to be regarded as trivial names having no status as generic names; in some cases the names may be regarded as *nomina nuda*.

A. Pertinent Rules.

Rule 28 of the International Bacteriological Code of Nomen-

clature is as follows:

"The gender of generic names is governed by the following regulations:
A Greek or Latin word adopted as a generic name retains its classical gender. In cases where the classical gender varies the author has the right of choice between the alternative genders. In doubtful cases, general usage should be followed."

"Generic names which are modern compounds formed from two or more Greek or Latin words take the gender of the last. If the ending is altered, however, the gender will follow it."

The bacteriological rule just cited is identical with the botanical rule.

B. The Classical Gender.

Apparently there was no Greek word βακτηρ - *bacter* - rod. There exist several Greek words which include the stem *bacter*.

βακτηρεύω - *bactereuo* Greek verb - to lean on a staff.
βακτηρία - *bacteria* Greek feminine noun - a staff, cane, rod.
βακτηριάζω - *bacteriazo* Greek verb - to support as a staff.
βακτηρίον - *bacterium* Greek neuter noun, diminutive of *bacteria*, - a small rod or staff.
βακτηρίδιον - *bacteridium* Greek neuter noun, diminutive - a small rod or staff.

Greek nouns whose stems end in τηρ are predominately masculine, a few feminine and none neuter. In fact, the rule states that stems ending in ρ (except those in αρ) are masculine. There would seem to be no classic precedent for regarding nouns ending in *-bacter* as anything but masculine.

C. Usage

A search of the literature shows considerable divergence in bacteriologic usage. The generic, subgeneric and pseudogeneric names proposed fall into the following groups.

1. Names giving no clue as to gender. These include *nomina nuda* with no species named, casual names, and insufficiently described or "physiological genera". Among these are the following:
Acetogluconobacter Asai 1935.
Arthrobacter Fischer 1895.
Astrobacter Jennings 1896.
Butylobacter Bakonyi 1931.
Cytobacter Duclaux 1895.
Euacetobacter Asai 1935.
Eugluconobacter Asai 1935.
Gleobacter Fischer 1895.
Lactobacter Beijerinck 1900.
Lipobacter de Kruyff 1906
Radiobacter
Saccharobacter Beijerinck
Urobacter Trecul?

2. Names definitely masculine.

Actinobacter Duclaux 1882
A. polymorphus.
Amoebobacter Winogradsky 1888.

A. roseus, A. bacillosus.
Amylobacter Duclaux 1895.
A. butylicus, A. ethylicus
Gluconoacetobacter Takahashi and Asai.
G. cerinus, G. roseus
Cystobacter Schroeter 1886
C. fuscus, C. erectus.
Glycobacter Wollmann 1912.
G.proteolyticus, G. peptolyticus.
Myxobacter Thaxter 1892.
M. aureus.
Streptobacter Schroeter 1886.
S. subtilis.

3. Names whose genders are not fixed by the specific epithets, could be masculine, feminine, or neuter.

Caulobacter Henrici and Johnson 1935.
C. vibrioides.
Gluconobacter Asae 1935
G. liquefaciens.
Phytobacter Groenewege 1912.
P. lycopersicum.

4. Names whose genders are not fixed because there have been proposals of both masculine and neuter specific epithets.

Acetobacter Beijerinck?
A. pastorianus, A. plicatum, A. melanogenum.
Achromobacter Bergey et al 1923.
A. liquefaciens, A. thalassius, A. iophagum, A. aquamarinus, A. delicatulum.
Azotobacter Beijerinck 1901.
A. chroococcum, A. agilis, A. indicum, A. vitreum.
Proteobacter Beijerinck____.
P. pseudopulcher, P. septicum.

5. Names definitely neuter.

Aerobacter Beijerinck____
A. aerogenes, A. viscosum.
Aplanobacter Smith 1905
A. anthracis, A. michiganense.
Citrobacter Werkman and Gillen 1932.
C. freundii, C. album.
Colibacter Pestana and Andrade 1940.
C. commune.
Granulobacter Beijerinck 1893.
G. butylicum, G. lactobutyricum.
Nitrobacter Beijerinck 1914.
N. oligotrophum.
Pectinobacter Makrinov 1916.
P. amylophilum.
Photobacter Beijerinck 1900.
P. luminosum, P. indicum.
Protaminobacter den Dooren de Jong 1926.
P. alboflavum, P. rubrum.
Siderobacter Naumann 1921.
S. duplex, S. lineare.

The following points may be noted:

1. Most (not all) of the earlier writers regarded generic names ending in *-bacter* as masculine.

2. Beijerinck proposed a considerable number of generic names ending in *-bacter* which he apparently regarded as neuter. Why this concept on his part is uncertain. Enlows (1920) notes that he used

Photobacter and *Photobacterium* somewhat interchangeably as generic names for the same species. It is possible that he as well as some later authors have regarded generic names ending in *-bacter* as shortened or abbreviated forms of generic names ending in *bacterium*, with the added inference that the genders of both would be neuter.

3. Generic names ending in *-bacterium* corresponding to those in *-bacter* are as follows:

Acetobacter----Acetobacterium
Achromobacter--Achromobacterium
Actinobacter---Actinobacterium
Arthrobacter---Arthrobacterium
Enterobacter---Enterobacterium
Flavobacter----Flavobacterium
Lactobacter----Lactobacterium
Myxobacter-----Myxobacterium
Photobacter----Photobacterium
Streptobacter--Streptobacterium

In some cases these names are synonyms, as noted above for *Photobacter*, in other cases they were independently applied to different groups of organisms, as *Myxobacter* and *Myxobacterium*.

INTERNATIONAL BULLETIN

OPINION NO. 3.

THE GENDER OF GENERIC NAMES ENDING IN -BACTER.

OPINION. The names of bacterial genera which end in -bacter should be regarded as having the masculine gender.

General Statement:
An incomplete search of the literature in bacteriology reveals that at least 42 generic names ending in -bacter have been proposed or used. The authors of these names are not in agreement as to the gender. In some cases the specific epithets indicate the generic name to be masculine, in other cases neuter, and in some genera both neuter and masculine epithets have been proposed.

The pertinent portion of Rule 28 of the International Bacteriological Code of Nomenclature is as follows:
"Generic names which are modern compounds formed from two or more Greek or Latin words take the gender of the last. If the ending is altered the gender will follow it."

There is no Greek word βακτηρ= *bacter*, and no Greek compound word ending in -βακτηρ= *-bacter* has thus far been found. Nouns related etymologically are

βάκτρον = *bactron* = *bactrum*, neuter noun (staff or rod).
βακτηρία = *bacteria*, feminine noun (staff or rod).
βακτηρίδιον = *bacteridium*, neuter diminutive noun (a small staff or rod).
βακτήριον = *bacterium*, neuter diminutive noun (a small staff or rod).

According to Rule 28 (2) quoted above, the change of *bactron* to *bacter* would require that the gender of the latter should be characteristic of nouns ending in -ηρ = *er*. Greek nouns that end in *-er* are predominantly masculine, a few are feminine, none is neuter.

A partial search of the literature indicates that the bacterial generic, sub-generic and pseudo-generic names which end in *-bacter* may be grouped as follows:

Names regarded by the authors as definitely masculine	8
Names having both masculine and neuter epithets	4
Names whose gender is not indicated by any of the epithets used	3
Names definitely regarded as neuter	10
Names giving no clue as to gender, *nomina nuda*, casual names, names insufficiently described or "physiological genera"	13

There are at least 10 generic names which differ only in the

endings *-bacter* and *-bacterium*. In some cases they are alternative names for the same genus, as *Acetobacter* and *Acetobacterium*. In other cases the two names are the names of definitely different genera, as *Myxobacter* and *Myxobacterium*. Apparently some authors have considered that *-bacter* is a contraction or abbreviation of *-bacterium*, and as having the same gender.

The fixing of *-bacter* either as masculine or as neuter will require the changing of the specific epithets as they are now recognized in certain genera. A check of the generic names ending in *-bacter* in the sixth edition of the Bergey Manual shows that there are 32 specific epithets in the genera recognized. To fix the gender of these as masculine would require the changing of the gender in ten cases. If the gender is fixed as neuter, four epithets would be changed. (1).

(1) The members of the Judicial Commission voted as follows:-
To regard generic names ending in *-bacter* as masculine, 8.
To regard generic names ending in *-bacter* as neuter, 3.
Abstentions, 3.

INCORRECT SPELLINGS OF SCIENTIFIC NAMES AND EPITHETS USED FOR BACTERIA.

Robert S. Breed, Geneva, New York.

Those who have the responsibility for editing publications containing scientific names of species and genera of bacteria sometimes find it difficult to determine the correct spelling to use for these names. The rules and recommendations found in the various Codes of Nomenclature appear to be worded simply and clearly. Yet, the application of these rules and recommendations involves interpretations of the meaning of words. It sometimes even involves the question whether the wording of the English or the French text of a Code is to be regarded as final or official.

The rule governing orthography (spelling) in the official English version of the Bacteriological Code of Nomenclature adopted at the Copenhagen Congress of Microbiology in 1947 reads as follows:

"Rule 27. The original spelling of a name or epithet must be retained, except in the case of a typographical error, or of a clearly unintentional orthographic error."

This wording is the same as that of the Botanical Code. The wording found in the Zoological Code differs slightly. In this Code the French text is accepted as official. Article 19 of the Zoological Code calls for the correction of the original spelling of a name in case there is "une faute de transcription, d'orthographie, ou impression". The complete but less satisfactorily worded English form of this rule reads "The original orthography of a name is to be preserved unless an error of transcription, a *lapsus calami*, or a typographical error is evident."

Certain rules in the Bacteriological Code governing the naming of genera and species also have a bearing on the correction of spelling or related errors. Thus Section 1, "Naming of groups of various ranks" in the Bacteriological Code reads:

"Rule 5. Names of genera and of sub-genera are substantives *(or adjectives used as substantives)* in the singular number and written with an initial capital. These names may be taken from any source whatever and *may even be composed in an arbitrary manner*". (Phrases that have a bearing on the spelling of names as originally proposed are italicized). Thus *Alcaligenes* and *Fusiformis* are adjectival substantives used as generic names and are correctly spelled.

Rule 6 reads: "Names of species are binary combinations consisting of the name of the genus followed by a single specific epithet..... Specific epithets are: (a) adjectives *which must agree grammatically with the generic name....*(c) substantives in the genitive.." (Italics again emphasize the phrase that is important from the standpoint of this discussion). Thus *Bacterium aurantiacus* Chester (1897) should be corrected to *Bacterium aurantiacum; Bacillus albolactus* Migula (1900) to *Bacillus albolactis.*

Recommendation 5a (5) which states that bacteriologists who form new generic or subgeneric names should avoid making names by combining words from different languages *(nomina hybrida)* implies that when, in spite of this recommendation, such hybrid names have been proposed they are not to be rejected on this score alone.

All of these rules and recommendations express the conviction of biologists, based on long experience, that, in order to attain the primary purpose of rules of nomenclature, i.e. fixity of names, these names must be accepted as originally proposed. "Other things such as absolute grammatical correctness, regularity or euphony of names, more or less prevailing custom, regard for persons, etc., notwithstanding their undeniable importance, are relatively accessory." (Principle 1 of the Bacteriological Code). Nevertheless Rule 27 calls for the correction of errors that are typographical or that are clearly unintentional and orthographic in nature.

Kirby (1), a protozoologist who has described species of parasitic bacteria in *Protozoa* (2) notes that there are important groups of taxonomists that take an extreme view in opposition to changes in spellings or other corrections of errors in scientific names. He writes:

'The Code of Nomenclature adopted by the American Ornithological Union (1908) deals with the subject of orthography in a very definite way. It is stated that the words used as names of genera and subgenera are of no definite construction, and are not to be rejected for faulty construction; and it is remarked that all that relates to grammatical and philological proprieties is not necessarily pertinent to zoological nomenclature. Variants of names resulting from recommendations by "purists" are considered untenable, and a canon of the A.O.U. Code directs that the original orthography of a name is to be rigidly preserved unless a typographical error is evident, with the exception that certain changes may be made in the termination of specific names.... Whereas this position has firm support, if not a source, in

the A.O.U. Code, and in other sets of regulations adopted by limited groups of zoologists, its proponents often state or imply that the International Rules of Zoological Nomenclature constitute their authority."

There are also certain statements that appear in Notes 1 to 4 of Rule 27 of the Bacteriological Code that assume that corrections are to be made only under specified conditions. Thus under Note 4 occurs the statement "The liberty of correcting a name must be used with reserve, especially if the change affects the first syllable, and above all, the first letter of the name."

Some of the many cases where authors or editors of bacteriological publications must decide whether "original spellings" are to be followed or whether "typographical and clearly unintentional orthographic errors" are to be corrected will now be examined.

Bacterial Generic Names and Specific Epithets that Show Typographical or Unintentional Orthographic Errors as They Were Originally Printed.

It is natural that many typographical errors are found in generic names and specific epithets of bacteria as they have been printed in our voluminous literature. Those that concern us at this time, however, are those that have occurred in these names as they were first printed. Sometimes it cannot be determined whether the error arose because of a fault of transcription in the manuscript furnished the printer, faulty proofreading, or whether the printer was responsible for the error. Hence, no attempt is made definitely to classify these mistakes. The first two cases discussed will illustrate this point.

There is an evident error in the specific epithet used by Wright (3) for a non-motile, and therefore, inactive water organism named by him *Bacillus decidiosus* (L. *desidiosus*. idle, inactive). Chester (4) corrected this spelling in the combination *Bacterium desidiosum*. However, the use of "c" in this epithet instead of "s" misled Bergey *et al* (5) into changing the spelling of this specific epithet to *deciduosum* possibly thinking it derived from L. *deciduus*, falling away. This appears in the combination *Flavobacterium deciduosum*. The spelling was, however, corrected by Bergey et al. in 1939 (6) to *Flavobacterium desidiosum*. This correction is of the type that is now sanctioned by Rule 27.

The use of the Latin word *desidiosus* caused a similar error in another specific epithet. The original spelling used by McBeth (7) for a cellulose digesting organism from soil that is relatively inactive is *Bacillus desiduosus*. This incor-

rect spelling again misled Bergey *et al.* (8) into changing the spelling in a way that was probably not intended by McBeth. Bergey *et al.* changed the spelling of the specific epithet to *deciduosa* in the combination *Cellulomonas deciduosa*. This was finally corrected to *Cellulomonas desidiosa* in Bergey's Manual (9). This is in accordance with Rule 27 of the present Bacteriological Code.

A few errors of a similar type occur in the names proposed by Migula (10). Migula noted nearly all of these in the final reading of the proof and they were corrected by him on page V of the Preface of this book. Occasionally, however, the incorrect spelling is still found in the literature. Thus, *Micrococcus pemphici* Migula, p. 191, is corrected on page V to *M. pemphigi; Bacillus cantextus* Migula, p. 522 to *B. contextus; Bacillus albolactus* Migula, p. 577 to *B. albolactis; Bacillus niustelae* Migula, p. 756 to *B. mustelae;* and *Bacillus butyris* Migula, p. 811, to *B. butyri*. All of these changes in spelling accord with Codes then in current use and with the present Rule 27 of the Bacteriological Code.

In fact, it might be argued that, because page V, on which the correct spelling is used, occurs before all of the other pages noted, the correct spellings were published earlier than the incorrect spellings.

When Hefferan (11) described the red chromogen that she isolated from water as *Bacillus utilis* it is fairly evident that the letter "r" dropped so low that it did not print. This is shown by the use of the spelling '*rutilus*' for the specific epithet in two other places (p. 313 and 457) in the paper by Hefferan. Unfortunately the '*utilis*' spelling was carried over into the first edition of Bergey's Manual (1923,89). The correction of this typographical error is in accord with Rule 27 except that some who feel that original names should stand, regardless of errors, may point out that the change of the first letter produces a situation where it may (and has) cost workers wasted time hunting through an index for a name they cannot find. There is reason for the statement under Rule 27 that the "liberty of correcting a name must be used with reserve especially if the change affects the first syllable, and above all the first letter of a name." In future editions of Bergey's Manual, both spellings will be found in the index.

In one curious instance, a difference in spelling, quite probably typographical in nature, has produced a genus name that has been generally accepted in bacteriology. However, it would become a homonym and therefore invalid if the origi-

nal spelling is used. Details of the description of the algal genus, *Gaillonella* Bory de St. Vincent (1823), are given by Buchanan (12). He also traces the various modifications of the original arrangement proposed later by Bory de St. Vincent, Ehrenberg and others. When Ehrenberg included the genus in his 1838 classification, he spelled the name *Gallionella* and it has since been widely used in bacteriology as a name different from *Gaillonella* with the type species *Gallionella ferruginea* Ehrenberg. After this early work, there never has been confusion between this genus of well known iron bacteria and the genus of diatoms known as *Gaillonella* Bory de St. Vincent. Buchanan concludes that if *Gallionella* Ehrenberg is rejected as invalid then *Didymohelix* Griffith (1853) becomes the valid name of the genus with *Didymohelix ochracea* Griffith as type species. The latter names have never been generally used. It will require action by the Judicial Commission to settle this problem.

An evident error, probably of transcription, occurs in the specific epithet of the following binomials proposed by Holland (13): *Bacillius hoffmannii* and *Corynebacterium hoffmanii*. These were evidently proposed to recognize the work of G. von Hofmann-Wellenhof who first recognized the pseudodiphtheria organism. The valid name for this species appears to be *Corynebacterium pseudodiphtheriticum* as given by Lehmann and Neumann (1896).

The genus name *Borrelia* is incorrectly spelled as *Borrellia* in the original description by Paillot (14). Formed from the name of the French scientist A. Borrel, it has been corrected by Holmes (15) in Bergey's Manual to *Borrelia* in accordance with Rule 27.

In the case of *Rhodorhagus* Bergey *et al.* (16) the original authors discovered and corrected this unintentionally incorrect transliteration to *Rhodorrhagus* Bergey *et al.* (17).

Names whose Spellings have been Changed by Subsequent Authors, Apparently without Adequate Justification.

Perhaps the best known case where the original spelling of a species name was changed by a subsequent author (whose changed spelling was then generally followed) occurred in connection with the binomial *Bacillus megaterium* De Bary (1884). This forms the basis for Opinion 1 issued by the Judicial Commission of the International Committee on Bacteriological Nomenclature (18). Here it is concluded that the original spelling must stand under Rule 27, there being no conclusive evidence that Schroeter's (19) change of spelling was made because of a typo-

graphical or unintentional orthographic error. It is unfortunate that Schroeter did not give his reason for changing the spelling of this species name to *Bacillus megatherium*.

In several instances where the spellings of names have been changed by subsequent authors, the changed spellings are clearly due to typographical or unintentional orthographic errors in the publication of the second author or authors. The following appear to fall in this grouping:

The specific epithet in the binomial, *Micromyces hofmanni*, is spelled by Gruber (1891) in accordance with the spelling used by G. von Hofmann-Wellenhof for his name. The name Hofmann is spelled incorrectly by Sauvageau and Radais (2) in the combination *Actinomyces hoffmanni*. Other authors have subsequently had trouble with the spelling of this species name.

The specific epithet, *thermophilus*, in *Bacillus thermophilus* Miquel (21) is incorrectly spelled as *termophilus* in *Bacterium termophilus* by Migula (22). However, *Thermobacterium* Fuhrmann (23) is a misprint for *Termobacterium* Zeidler (24). In these cases there appears to have been confusion between the two Greek words *terma*, end, and *therme*, heat, although the misprints may have been typographical in nature.

Zaogalactina imetrofa Sette (25) is more correctly transliterated from the Greek as *Zaogalactina imetropha* (Montague. 1853; Schroeter, 1872; Trevisan, 1879. See Breed and Breed (26)). The epithets in this binomial have, however, been more frequently spelled incorrectly because of typographical errors or errors of transcription. Thus we have *Zoogalactina immetropha* Chester (27) and *Bacillus impetrophus* Bergey *et al.* (28). Other authors have sometimes copied these incorrect spellings.

Bizio's (29) name for this organism given the preceding year is *Serratia marcescens*. As this is incorrectly spelled as *Serratia marescens* in a later paper by Bizio (30) subsequent authors have sometimes copied this error that is presumably typographical in nature.

Other cases where subsequent authors have misspelled a specific epithet may be listed. The first is found in *Bacillus haumani* Soriano (31) which is spelled *Bacillus haumanni* by Arnaudi (32). Prévot (33) has copied the incorrect spelling in *Clostridium haumanni*. The second case of this sort is found in *Bacillus buccalis minutus* Sternberg (34) as the second word in the trinomial is spelled *bucallis* by Chester (35) in the bionomial *Bacterium bucallis*. A third case of the same sort is found in the spe-

cific epithet which is correctly spelled in the binomial *Actinomyces gruberi* Terni (36) and incorrectly spelled in the binomial used for the same species, *Streptothrix grueberi* Sanfelice (37). Still another case that appears to fit into the same type of error is found in *Micrococcus corallinus*. Cantani (38) uses the correct spelling for this specific epithet but it appears as *coralinus* in the combination *Rhodococcus coralinus* used for the same species by Levine and Soppeland (39).

In one case, a subsequent author has preferred a different spelling from the one used by the author that proposed the binomial. In this case it appears that Rule 27 would require that the spelling first used be the one finally accepted. Thus Fluegge (40) proposed the name *Bacillus fluorescens putidus* which Trevisan (41) changed to the binomial *Bacillus putidus*. However, Kruse (42) changed the spelling '*putidus*' to '*putridus*'. This spelling has been incorrectly used by many subsequent authors.

A related but not identical problem has arisen in the case of the anaerobic spore-former named *Bacillus de rossii* by Carbone and Venturelli (43). This has been renamed *Clostridium derossii* by Spray (44), while Prévot (45), feeling that the use of the 'de' in this case is ungrammatical, has renamed this species *Endosporus rossii*. Here again Rule 27 would seem to apply. Under this rule Dr. Prévot has agreed that the original spelling in this case (personal communication) should stand, thus supporting the view of those that argue that, in the interest of stability, original spellings should be retained.

This case is interesting because in quite a series of generic and specific epithets the connectives that indicate origin or territorial estate are sometimes used and sometimes omitted. Thus we have the following where these connectives have been incorporated in the original spelling of the name or epithet: *Detoniella* Trevisan (46), *Urococcus vantieghemii* Miquel (1893), *Bacterium delesseriae* Lundestad (1928), *Bacillus lemonnieri* Lasseur (1913), *Rhodomicrobium vannielli* Duchow and Douglas, *Bacillus debaryanus* Klein (1889), *Bacterium lepierrei* Chester (1901), *Pseudomonas dacunhae* Gray and Thornton (1928) from the Island d'Acunha, *Photobacterium delgadense* Fischer (1888) from Ponte del Gada. The following names also appear: *Macintoshillus* Heller (1922) from J. McIntosh, *Bacillus sanfelicei* Migula (1900) and *Nocardia sanfelicei* Redaelli (1928).

Titles or even phrases have also sometimes been used in the epithets applied to serotypes in the genus *Salmonella*. Thus we have *Salmonella Saint Paul*

Edwards and Bruner (48), *Salmonella Dar-es-Salaam* Brown, Duncan and Henry (49) (arabic meaning 'Place of Peace'), *Salmonella Tel Aviv* (hebraic meaning 'Hill of our Fathers') Kauffman (50), and *Salmonella San Diego* Kauffman.(51).

As the recommendation quoted above does not require that connectives in patronymics be used, such names as the following are also found and when proposed in this form are acceptable under Rule 27. Thus we have *Micrococcus dantecii* Chester (52) and *Bacillus danteci* Kruse (53) from le Dantec, *Hiblerillus* Heller (54) from von Hibler, *Ermengemillus* Heller (55) from van Ermengem, *Herellea* De Bord (56) from d'-Herelle, *Ehrlichia* Moskovsky (57) from von Ehrlich, *Bacterium laeri* Migula (58) from van Laer. Similarly we find titles sometimes dropped as in *Eberthella pauloensis* Mello (59), *Escherichia pauloensis* Mello (60), and *Salmonella pauloensis* Gomes (61), all three from Sao Paulo, and *Salmonella luciana* Moran, Edwards and Bruner (62) from St. Lucie, Florida.

While it is quite certainly true that this discussion of typographical and unintentional orthographic errors in bacterial names is not complete, it is complete enough to show the types of problems that taxonomists meet in this field. It also shows that, in general, bacteriologists either have proposed names in accord with or have been content to accept Rule 27. However, at times, as is natural, purists have found it distasteful to use original spellings that they do not feel are correct. In other types of orthographic variations that will be discussed later, the tendency to change names from the form used by the original author becomes more pronounced.

Summary

For the convenience of those who wish to find the names discussed in this paper, an alphabetical list has been prepared. The generic names quoted in parentheses are those used by the original author of the binomial. Where the question discussed was one of spelling the correct spelling has been used.

albolactis (Bacillus), p. 39,41.
Alcaligenes, p. 38.
aurantiacum (Bacterium), p. 39.
Borrelia, p. 42.
buccalis minutus (Bacillus), p. 43.
butyri (Bacillus), p. 41.
contextus (Bacillus), p. 41.
corallinus (Micrococcus), p. 44.
dacunhae (Pseudomonas), p. 44.
danteci (Bacillus), p. 45.
dantecii (Micrococcus), p. 45.
Dar-es-Salaam (Salmonella), p. 45.
debaryanus (Bacillus), p. 44.
delesseriae (Bacterium), p. 44.
delgadense (Photobacterium), p. 44.
derossii (Clostridium), p. 44.
Detoniella, p. 44.

desidiosus (Cellulomonas), p. 40.
desidiosum (Flavobacterium), p. 40.
Ehrlichia, p. 45.
Ermengemillus, p. 45.
Fusiformis, p. 38.
Gallionella, p. 42.
gruberi (Actinomyces), p. 44.
haumani (Bacillus), p. 43.
Herellea, p. 45.
Hiblerillus, p. 45.
hofmanni (Corynebacterium), p. 42.
hofmanni (Micromyces), p. 42.
imetrofa (Zaogalactina), p. 43.
laerii (Bacterium), p. 44.
lemonnieri (Bacillus), p. 44.
lepierrei (Bacterium), p. 44.
luciana (Salmonella), p. 45.
Macintoshillus, p. 44.
marcescens (Serratia), p. 43.
megaterium (Bacillus), p. 42.
mustelae (Bacillus), p. 41.
pauloensis (Eberthella), p. 45.
pauloensis (Escherichia), p. 45.
pauloensis (Salmonella), p. 45.
pemphigi (Micrococcus), p. 41.
pseudodiphtheriticum (Corynebacterium), p. 42.
putidus (Pseudomonas) p. 44.
Rhodorrhagus, p. 42.
rutilis (Bacillus), p. 41.
Saint Paul (Salmonella), p. 44.
San Diego (Salmonella), p. 45.
sanfelicei (Bacillus), p. 44.
sanfelicei (Nocardia), p. 44.
Tel Aviv (Salmonella), p. 45.
Termobacterium, p. 43.
thermophilus (Bacillus), p. 43.
vannielii (Rhodomicrobium), p. 44.
vantieghemii (Urococcus), p. 44.
Zaogalactina, p. 43.

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